Annual Review 1978-1979

U.S. LEAD INDUSTRY

6/16/81 A 6200-1

Lead Industries Association, Inc.

SUMMARY

From nearly any vantage point, both 1978 and 1979 were strong, upbeat years for the lead industry. As a result of interruptions due to strikes, sustained consumption and heavy buying by East European Socialist Countries, lead prices increased rather steadily from the last quarter of 1978 to a peak in October, 1979, of over 60 cents per pound. Consumption, while not quite a record, did mark 1978 as the third best year ever at 1,579,300 short tons, and although consumer interest slackened in the final quarter, 1979 ended with a respectable reported consumption of more than 1.5 million short tons. Growing weakness in the domestic lead market was confirmed by final 1979 statistics which showed production steady; producer stocks dramatically increasing; and shipments declining (Table 3). Demand for lead dropped as new car sales slumped and need for Original Equipment Manufacture (OEM) batteries waned correspondingly. Also, because of the generally mild winter across the U.S., there was, at the same time, less demand for replacement batteries. For example, the Battery Council International (BCI) reported a 12% drop from October to November in shipments of automotive replacement batteries (See Table 1 & Figure 1 for general summaries).

Mine Production—U.S. mine production decreased for the fourth and fifth years in a row in 1978 and 1979, although production from Missouri increased slightly in both years (See Table 2). In 1978 and 1979, the state of Missouri supplied 87% and 90% respectively of the lead mined in the U.S. Next largest producing state was Idaho with just over 8% both years.

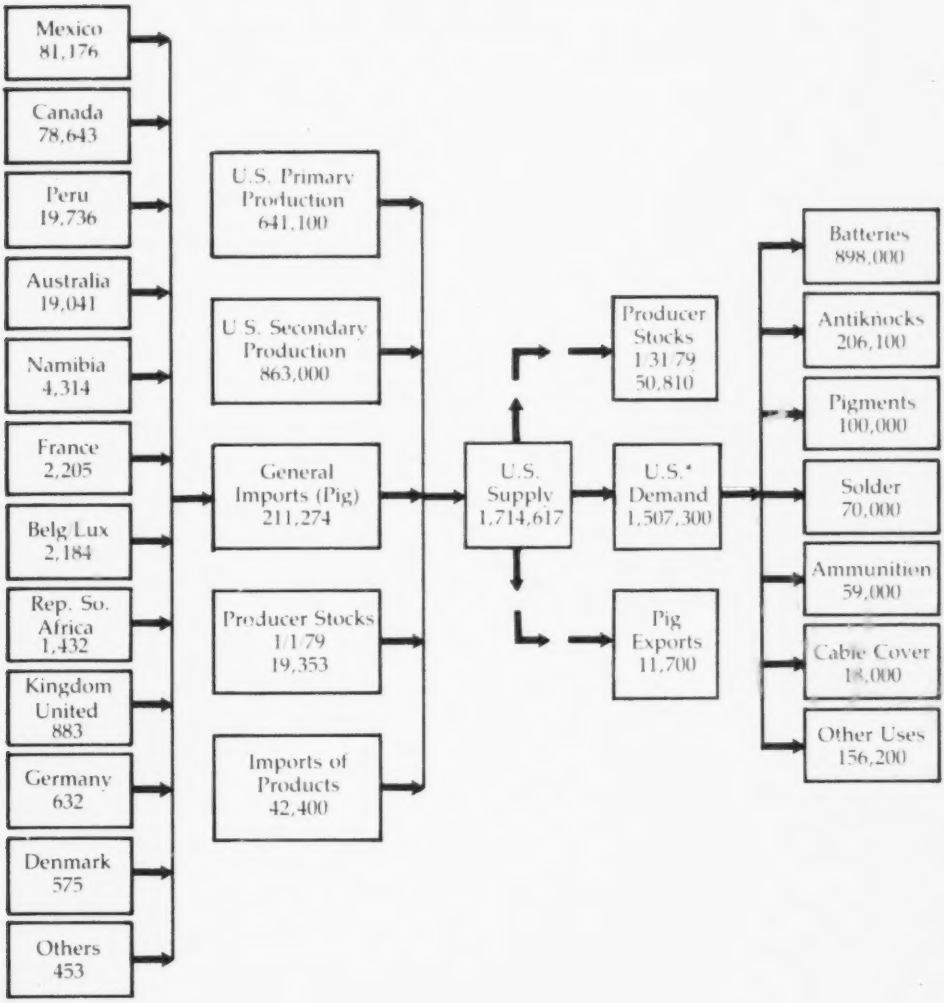
TABLE 2
MINE PRODUCTION OF RECOVERABLE LEAD IN THE U.S.
(In Short Tons)

STATES	1975	1976	1977	1978	1979[P]
Arizona	420	338	317	459	485
Colorado	27,088	26,749	22,994	16,701	8,817
Idaho	50,395	53,636	47,258	49,340	46,253
Maine	364	216	177	—	—
Missouri	515,958	500,991	500,255	509,005	514,448
Montana	205	92	106	146	330
Nevada	2,976	582	743	720	31
New York	3,027	3,196	2,778	1,091	(W)
Utah	12,679	16,297	10,750	2,801	10
Virginia	2,551	1,946	2,202	1,987	(W)
Other States[1]	5,801	5,503	4,911	1,601	2,958
TOTAL	621,464	609,546	592,491	583,851	573,332

[P] Preliminary
[1] "Other States" includes: Alaska, Calif., Fl., Kentucky, New Mexico, Okla., S. Dak., Texas, Washington and Wisconsin
(W) Withheld, included with "Other States."
Source: U.S. Bureau of Mines

FIGURE 1

UNITED STATES
SUPPLY-DEMAND RELATIONSHIPS
LEAD-1979
(In Short Tons)



Source: U.S. Bureau of Mines

*Does not reflect consumer stocks and apparent unreported metal.

Environmental difficulties, lower ore grades and closing of zinc operations where lead was also produced have all contributed to the reduction in lead mining outside of Missouri. It has been reported that at various times in 1978 sixteen lead producing mines, mostly located in North America, had closed—although some were only of a temporary nature. Strikes in Peru and at the Ozark lead operation in Sweetwater, Missouri, as well as elsewhere dropped world mine production in 1979 and complicated the domestic situation.

TABLE 3
DOMESTIC SHIPMENTS AND PRODUCTION OF PRIMARY LEAD
(In Short Tons)

	Shipments		Production	
	1978	1979	1978	1979
Jan	59,913	56,707	59,996	52,990
Feb	49,656	54,746	50,061	52,237
Mar	51,259	58,928	55,256	60,632
Apr	43,517	52,212	55,466	52,493
May	49,010	58,549	49,057	58,065
Jun	44,068	55,151	44,825	55,026
Jul	44,251	56,051	42,450	52,606
Aug	56,318	46,999	50,362	49,878
Sep	56,120	45,910	51,487	45,400
Oct	62,780	52,889	60,872	52,936
Nov	54,490	39,676	55,110	54,598
Dec	53,135	30,790	54,249	54,252
Year	624,517	608,608	629,191	641,113

Source: American Bureau of Metal Statistics

Secondary Lead Recovery—As if adding emphasis to the importance of recycling, the secondary recovery of lead increased for the fifth year in a row to an estimated 883,000 short tons. The ratio of secondary production of refined lead to antimonial lead remained about the same: 40/60 during 1978, but jumped to 48% refined lead in 1979 (See Table 4). During 1978 and 1979 there were recurring reports of difficulty in obtaining scrap to feed the secondary furnaces due to heavy exports.

About 109,000 short tons of lead scrap were exported in 1978, and about 132,000 short tons were exported in 1979. Both years were up considerably from the 85,000 tons exported in 1977. The increases were most likely due to foreign competition for smelter feed, resulting in higher scrap prices overseas.

Old battery plates continued to represent 60 to 70% of the feed stock for secondary smelters, as reported to the U.S. Bureau of Mines. Other less important feed materials were: cable covering, type metals and drosses and residues.

TABLE 4
SECONDARY LEAD RECOVERY IN THE U.S.
(In Short Tons)

As Refined Lead:	1975	1976	1977	1978	1979(E)
Primary Plants	—	29	95	1,371	3,155
Secondary Smelters	271,297	310,981	334,069	310,124	385,102
Sub Total	271,297	311,010	334,164	311,495	388,257
In Antimonial Lead:					
Primary Plants	3,337	1,371	3,364	1,523	2,000
Secondary Smelters	311,783	340,596	419,247	450,325	415,588
Sub Total	315,120	341,967	422,611	451,848	417,588
In Other Alloys:	72,039	73,592	78,326	84,593	77,511
GRAND TOTAL	658,456	726,569	835,101	847,936	883,356

Source: U.S. Bur. of Mines
(E) Estimated by LIA

U.S. Government Stockpile—The U.S. Government currently holds 601,000 short tons of lead in its stockpile, and the present stockpile goal has been raised from the 865,000 tons announced on October 1, 1976 to 1,100,000 short tons as of May 2, 1980. There were no stockpile sales in either 1978 or 1979.

Producer Stocks—Stocks at primary refiners were quite low, 15,118 short tons, at the beginning of 1978, and remained so until May, when the traditional slump in battery buying raised the level to about 31,000 tons. By August, 1978, stocks began to drop again, and at year end were down to 19,025. From then until November, 1979, producer stocks remained very low, dipping to about 10,000 tons in August, until a sudden upsurge to 27,000 tons surfaced in the December 1 report. As 1979 closed, producer stocks had risen to 50,708 tons—a startling portent of the sagging economy (See Table 5).

Contrary to the situation with primary refiner stocks, total consumer and secondary smelter stocks rose rather steadily throughout 1979. After an initial drop in January to about 138,000 short tons, they ended 1979 at about 169,000 tons (See Table 6).

Production and Shipments—U.S. primary smelter production and shipments were in close balance throughout 1978 and 1979, except for November and December 1979, when shipments were off about 25% and 43% respectively, from the previous 10-month average (See Table 3 and Figure 2).

Due to good demand and increasing prices for the metal during much of 1978 and 1979, production was such as to provide a 2.8% increase—to 629,191 short tons—in 1978, and another 1.9% increase in 1979.

TABLE 5
U.S. PRIMARY REFINERY STOCKS AT BEGINNING OF MONTH IN OWN PLANT

	1978	1979
Jan	15,118	19,025
Feb	15,051	15,119
Mar	15,456	12,591
Apr	19,453	14,144
May	31,402	14,264
Jun	31,292	13,780
Jul	32,049	13,655
Aug	30,098	10,059
Sep	23,991	12,938
Oct	19,358	12,428
Nov	17,301	12,324
Dec	17,911	27,246
Year End	19,025	50,708

Source: American Bureau of Metal Statistics

End of:	1975	1976	1977	1978	1979
Refined Soft Lead	85,109	87,774	81,575	79,438	105,441
Antimonial Lead	41,569	34,106	43,263	48,961	54,220
Lead in Alloys	5,059	6,000	7,351	8,338	8,098
Copper Base Scrap	1,577	1,730	1,617	1,310	1,109
TOTALS	133,314	129,610	133,806	138,047	168,868

Source: U.S. Bureau of Mines

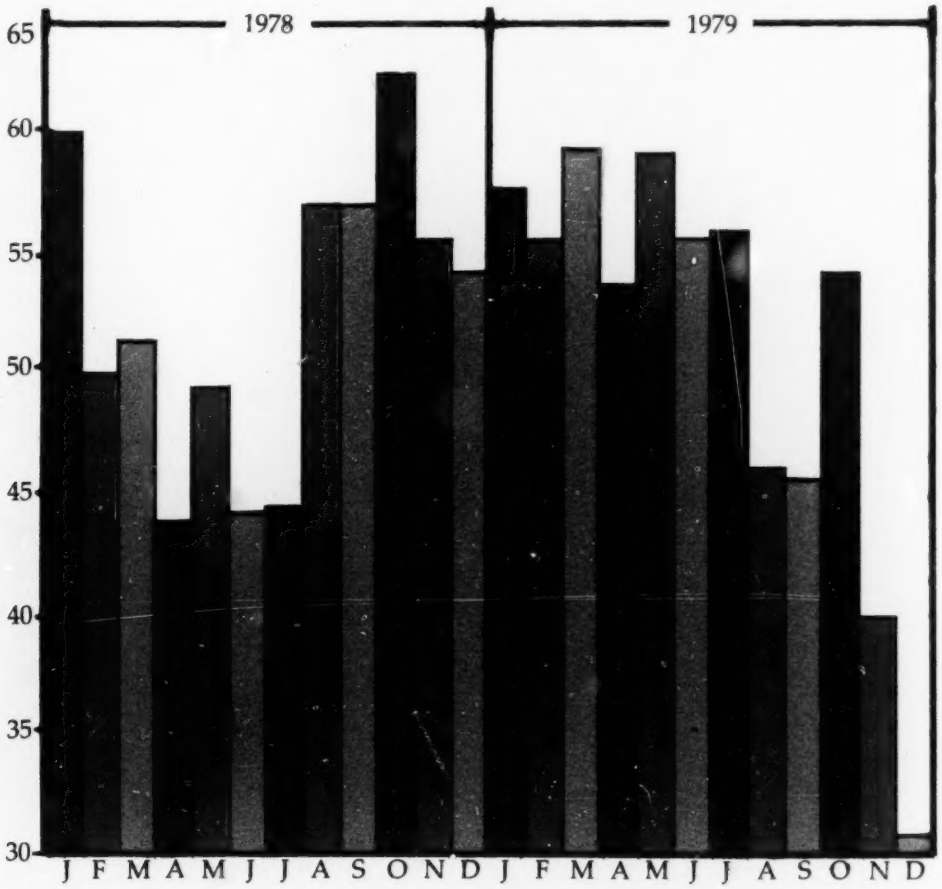
Imports—General imports of lead to the United States fell to 313,269 tons in 1978, down 10% from 1977, and were down another 48,000 tons, or 15.5%, to 264,580 in 1979.

Pig and bar imports dipped 6.5% in 1978, and decreased again by 13.4% in 1979. Mexico, Canada, Peru and Australia, in that order, continued as the leading importers of lead metal to the U.S. These four countries accounted for 94% of U.S. pig lead imports in 1979.

Imports of ore and matte in both 1978 and 1979 dropped by about 20% and 24.5%, respectively, from previous years (See Table 7).

The general drop in imports was due in large part to the world-wide shortage of concentrates, and to the heavy purchases of both metal and concentrates by Eastern European nations, especially the Soviet Union. The Socialist Bloc reportedly purchased about 125,000 short tons of lead-in-concentrates and 110,000 tons of pig lead from various western sources in 1978, and a like amount was absorbed in 1979.

FIGURE 2
LEAD SHIPMENTS BY U.S. PRIMARY REFINERS



Consumption—Estimated consumption of lead in the U.S., based on preliminary reports from the USBM, dropped approximately 4.6% in 1979, compared to 1978. Total for 1978 was nearly the same as 1977, and ranked that year third—after 1974 and 1977—amongst record highs.

Back-to-back with a record year for consumption, few markets for lead in 1978 showed increased growth over 1977. Nevertheless, brass and bronze, cable covering and solder did show some minor gains. Lead acid batteries continued their remarkable growth, increasing by another 2.5% over 1977. It is believed the gains in brass and bronze, sustained through 1979 as well, represent growth in usage in military hardware, amongst other applications. With respect to cable sheathing, 1979 marks the first change in three years, and the first gain in many years. It is the belief of the LIA, based on research performed by the International Lead Zinc

TABLE 7
GENERAL IMPORTS OF LEAD TO THE U.S.
(Short tons, lead content)

	1975	1976	1977	1978	1979
ORE, MATTE, etc.;					
Australia	15,916	11,215	18,289	7,189	2,119
Bolivia	—	—	—	1,343	—
Canada	28,949	27,673	17,669	21,591	14,069
Colombia	112	226	147	95	150
Greenland	6,552	5,104	—	—	—
Honduras	19,153	22,028	26,476	14,797	12,038
Japan	—	—	—	—	—
Mexico	—	92	1,146	5,046	1,816
Nicaragua	1,182	762	1,746	799	—
Peru	15,696	9,263	6,967	6,996	13,717
Other Countries	—	2	901	549	181
Total	87,560	76,365	73,341	58,405	44,090
BASE BULLION:					
Belgium/Luxembourg	19	72	110	—	—
Canada	65	730	494	4,402	1,823
Mexico	378	1,532	4,475	287	—
Morocco	—	—	1,098	—	—
South-West Africa	—	—	1,507	—	—
Other Countries	—	—	115	60	30
Total	462	2,334	8,069	4,748	1,853
PIG AND BARS:					
Australia	—	6,123	21,891	17,997	19,041
Belgium/Luxembourg	2,058	168	7,614	8,244	2,184
Canada	30,688	47,612	83,153	77,578	78,643
Denmark	420	429	192	725	575
France	—	—	1,075	1,653	2,205
Germany, West	2,614	10	20,645	9,323	632
Japan	78	3	—	—	—
Mexico	29,637	44,290	79,121	88,420	81,176
Morocco	—	2,756	—	6,622	—
Netherlands	535	2,221	110	567	—
Peru	19,876	19,733	33,548	28,357	19,736
South Africa, Republic of	1,120	84	2,603	—	1,432
South-West Africa	—	—	—	—	4,314
Sweden	—	—	—	1,110	—
Thailand	437	408	274	200	—
United Kingdom	2,638	2,022	2,849	1,900	883
Yugoslavia	10,181	19,944	7,594	—	—
Other Countries	229	129	601	1,259	453
Total	100,511	145,932	261,270	243,956	211,274
Reclaimed Scrap, etc.	5,365	4,413	6,771	6,187	7,363
GRAND TOTAL	193,898	229,044	349,451	313,296	264,580

Source: U.S. Bureau of Mines

Research Organization, and reports from cable producers and consumers alike that lead sheathing offers the only long-term, reliable moisture barrier available at low cost to the cable-using industry. Reports of failures in plastic sheathed cable due to "treeing" now abound, and responsible consumers—such as major power utilities—are switching back to lead sheathed cable for reliability and ultimate lower costs.

A substantial portion of the lead market is tied directly to the automobile and the construction industries. In view of this, and in an effort to connect the statistical end-use reporting more directly to these end markets, the Bureau of Mines has adjusted its "consumption" report to show more detail in those general areas (See Table 8 and Figure 3).

FIGURE 3
UNITED STATES LEAD CONSUMPTION BY PRODUCT - 1979
TOTAL—1,507,300 SHORT TONS

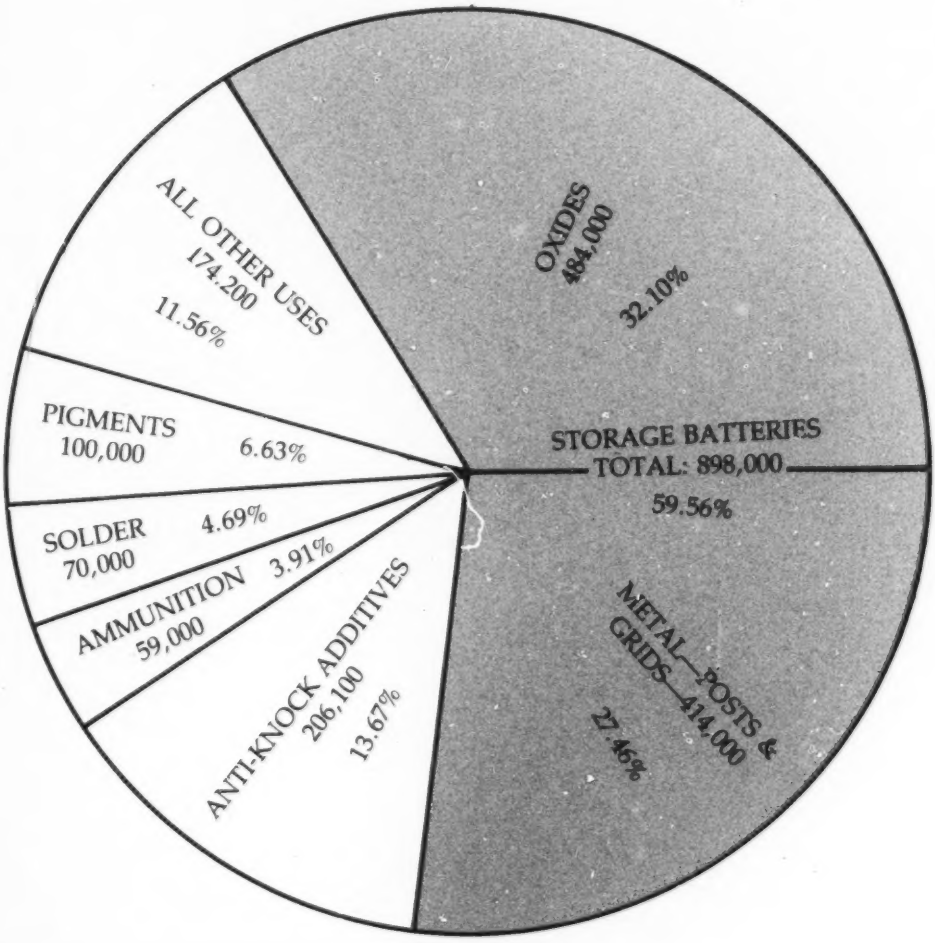


TABLE 8
CONSUMPTION OF LEAD IN THE UNITED STATES[1]
Lead Content - Short Tons

	1975	1976	1977	1978	1979[2]
Ammunition - Shot & Bullets	75,081	73,478	68,390	61,482	59,000
Bearing Metals Total	12,184	13,063	11,985	10,483	10,600
Machinery except electrical	—	—	—	—	1,000
Electrical & electronic equipment	—	—	—	—	100
Motor vehicles & equipment	—	—	—	—	4,200
Other transportation equipment	—	—	—	—	5,300
Brass & Bronze - Billets & Ingots	13,404	15,660	16,698	18,190	20,000
Cable Covering - Power & Communication	22,099	15,930	15,107	15,268	18,000
Calking Lead - Building Construction	14,296	12,475	9.618	10,923	8,800
Casting Metals Total	7,711	6,708	5,983	3,980	25,000
Electrical machinery & equipment	—	—	—	—	1,200
Motor vehicles & equipment	—	—	—	—	2,800
Other transportation & equipment	—	—	—	—	16,000
Nuclear radiation shielding	—	—	—	—	5,000
Pipes, Traps & Other Extruded Products Total	14,233	13,789	11,635	11,551	8,000
Building construction	—	—	—	—	7,000
Storage tanks, process vessels, etc.	—	—	—	—	1,000
Sheet Lead Total	24,859	24,438	16,761	13,918	22,500
Building construction	—	—	—	—	15,600
Storage tanks, process vessels, etc.	—	—	—	—	6,900
Solder Total	57,344	63,324	64,286	75,387	70,000
Building construction	—	—	—	—	11,000
Metal cans & shipping containers	—	—	—	—	16,000

TABLE 1
SUMMARY OF U.S. LEAD STATISTICS[1]
(In Short Tons)

Year	Domestic Refinery Prod.		Imports		Stockpile	Prod. & Consumer Stocks		Net Inventory Difference	Exports	Lead Consumption	
	Primary	Secondary	Metal for Consumption	Products	Releases	Jan. 1	Dec. 31	(year-to-year)	(Pig)	Apparent	Reported
1975	641,400	658,500	99,500	28,000	7,000	203,800	214,600	+10,800	21,300	1,402,300	1,297,100
1976	658,400	726,600	144,300	26,000	—	214,600	173,400	−41,200	5,900	1,590,600	1,490,100
1977	611,600	835,100	253,600	36,000	—	173,400	149,200	−24,200	9,800	1,750,700	1,582,300
1978	629,100	847,900	248,500	45,800	—	149,200	157,400	+ 8,200	9,100	1,754,000	1,579,300
1979	641,100	883,000	201,200	42,400	—	157,400	181,700	+24,300	11,700	1,731,700	1,507,300[2]

(1) Source: U.S. Bureau of Mines

(2) Estimated by LIA as USBM Final

TABLE 8
CONSUMPTION OF LEAD IN THE UNITED STATES (Continued)
Lead Content - Short Tons

	1975	1976	1977	1978	1979[2]
Electronic components & accessories	—	—	—	—	18,000
Other electrical machinery & equipment	—	—	—	—	4,000
Motor vehicles & equipment	—	—	—	—	21,000
Storage Battery Grids, Posts, etc. Total	326,714	383,844	459,335	454,774	414,000
Storage batteries - SLI automotive	—	—	—	—	386,000
Storage batteries - industrial & traction	—	—	—	—	28,000
Storage Battery Oxides Total	372,700	438,560	486,541	514,459	484,000
Storage batteries - SLI automotive	—	—	—	—	462,000
Storage batteries - industrial & traction	—	—	—	—	22,000
Terne Metal - Motor Vehicles & Equipment	1,511	1,595	1,644	4,165	5,000
Type Metal - Printing & Allied Industries	16,211	15,007	12,561	11,899	11,000
Other Metal Products	29,672	34,352	29,297	31,960	13,300
Pigments Total	79,072	105,591	99,982	101,018	100,000
Paints	—	—	—	—	29,500
Glass & ceramic products	—	—	—	—	53,700
Other pigments	—	—	—	—	16,800
Chemicals - Petroleum Refining	208,786	239,904	233,039	196,576	206,100
Miscellaneous Uses	21,221	32,354	39,476	43,294	32,000
Total Consumption	1,297,098	1,490,072	1,582,338	1,579,327	1,507,300[2]

(1) Source: U.S. Bureau of Mines
(2) Estimated by LIA as USBM Final

One lead market, tied to the automobile, and worthy of further comment, is antiknocks. Lead antiknocks appear in Table 8 under the category "Chemicals—Petroleum Refining." The addition of lead antiknocks to gasoline has been embroiled in controversy since the 1960's. Beginning in 1973, catalytic converters came into use on most new cars made in the U.S., and these cars are designed to use unleaded gas only. The result is that each year, as new cars populate the highway, and older, leaded-gas-burning vehicles are phased out, less leaded gasoline is required for motoring (See Table 9 and Figure 5).

TABLE 9

BREAKOUT OF GASOLINE DEMAND (U.S.)

	Unleaded	Leaded regular (Percent)	Leaded premium
1977	25.3	59.4	15.4
1978	33.3	54.4	12.3
1979	41.2	49.1	9.7
1980	49.4	43.2	7.5
1981	56.9	37.4	5.6
1982	63.6	32.2	5.6
1983	69.2	27.7	3.1
1984	73.8	23.8	2.3
1985	77.5	20.8	1.7

Source: Department of Energy

There is strong belief in the lead industry, as well as in the automotive and petroleum sectors, that emission levels set for U.S. automobiles by the "Clean Air Act" are too stringent. Couched another way, the costs of achieving these levels far exceed expected health benefits, and by holding emission level requirements at 1978-9 levels (See Table 10), many benefits would accrue. For instance, engines are now developed that can equal or surpass 1978-9 emission standards—*without catalytic converters* and *with leaded regular gas*. Use of such engines in today's automobiles would result in an immediate 4-to-5 mile-per-gallon improvement, and could save an estimated 500,000 barrels of gasoline per day, because leaded gas requires less crude to produce.

TABLE 10

EMISSION LEVELS FOR AUTOMOBILES SET BY CLEAN AIR ACT OF 1970*

Year	Grams Per Mile Permitted		
	Hydrocarbons	Carbon Monoxide	Oxides of Nitrogen
1978	1.5	15	2.0
1979	"	"	"
1980	0.41	7.0	2.0
1981	0.41	3.4	1.0

*Figures as amended by Congress in 1973.

Of course, such benefits could only occur if the Environmental Protection Agency (EPA) freezes its phasedown of the use of lead in gasoline at

the current 0.8 gram-per-gallon (gpg) level. On April 5, 1979, President Carter directed EPA to delay the mandated phasedown and a one-year suspension of EPA's 0.5 gpg requirement is in effect until October 1, 1980, at which time, unless the freeze is extended, the permissible level of lead in pool stock* must drop to 0.5 gpg. Higher levels of lead were permitted (that is, the lead phasedown regulation was suspended by President Carter) when the crude oil supply tightened worldwide in 1979. It has been stated that at constant gasoline production, the energy equivalent of 60,000 barrels per day of crude oil could be saved by retaining the 0.8 gram level in 1980, rather than going to 0.5 grams per gallon.

Regarding 1978-79 consumption, as expected, use of lead in antiknock production for U.S. gasoline markets declined in 1978, dropping from the 1977 level of 233,000 short tons to 197,000 short tons in 1978. Although total consumption figures in Table 8 show a reversal in 1979, with antiknock usage increasing slightly to 206,000 short tons, this is clearly due to a dramatic increase in exports of antiknock fluids in 1979 (See Figure 4, Lead Contained in Antiknock Fluid Exports).

Use of lead for lead acid batteries continued to grow in 1978, as stated previously, requiring about 60% of the lead reported consumed that year. Both OEM and replacement battery usage declined in 1979, in line with the major decrease in domestic automobile production, and reflecting, as well, the mild winter weather generally experienced across the U.S.

According to the Battery Council International, shipments of OEM batteries in 1978 were 15,192,300 units and in 1979, 14,390,000 units. Total replacement battery shipments were 56,390,000 units in 1978, and 53,800,000 units in 1979. Growth in use of the maintenance-free or lead-calcium battery also continued in 1979 with about 75-80% of the OEM batteries being non-antimonial, as well as about 25% of the replacement-type batteries being made without antimony.

Industrial battery usage, as reported directly to LIA, continued growth in both 1978 and 1979, amounting to 93,385 and 101,918 short tons, respectively, up from the 90,853 short tons reported in 1977.

*U.S. phasedown restrictions are based on the maximum of lead in the pool for all motor gasoline produced by an individual refinery.

FIGURE 4
LEAD CONTAINED IN ANTIKNOCK FLUID EXPORTS

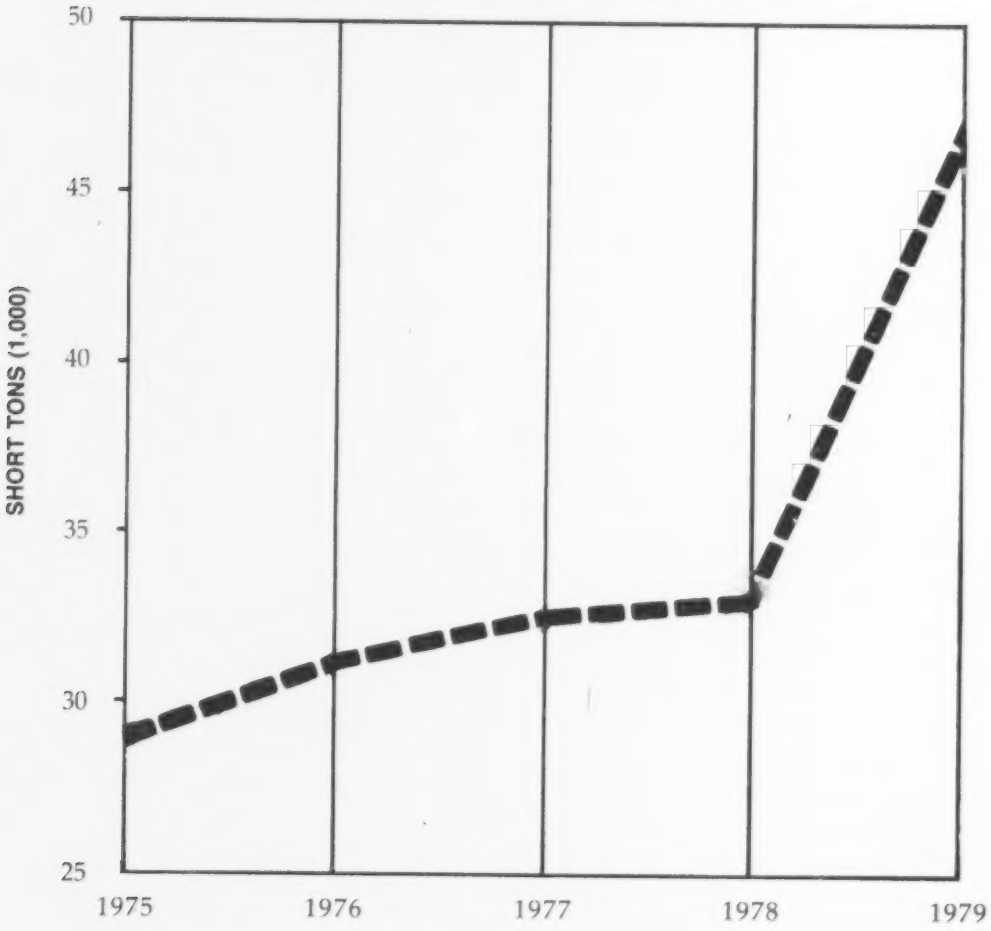
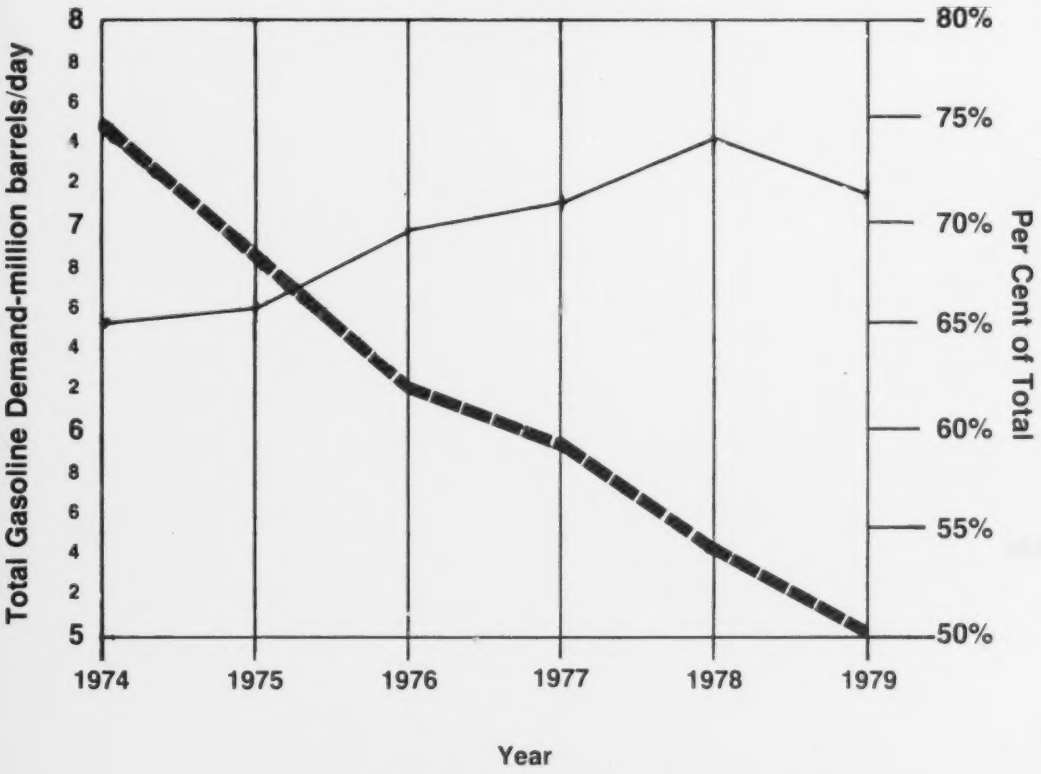


FIGURE 5

LEADED REGULAR AS A PERCENT OF TOTAL MOTOR GASOLINE DEMAND



Left Side: Trend of Motor Gasoline Demand (Solid Line)
Right Side: Trend for Leaded Regular Sales (Dotted Line)

WORLD OUTLOOK

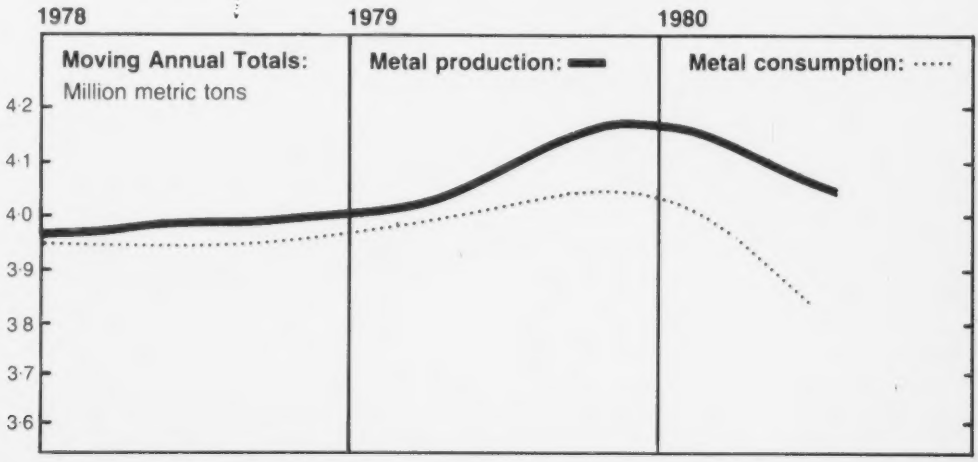
The lagging economy, both in the U. S. and worldwide, beginning with the last quarter of 1979, and deepening in 1980, brought about a sharp downturn in the use of lead for nearly all applications (See Figure 6).

During the first half of 1980, domestic lead prices dropped sharply from the year end 1979 level of about 56 cents per pound to a level in July of 34 cents (See Table 11 and Fig. 7). Worldwide stocks of lead diminished during the first half of 1980, and nearly 90,000 short tons of primary lead was exported from the U. S. in the first seven months of 1980 to help fill the gap in Europe. The U. N. sponsored International Lead Zinc Study Group said in April, 1980, that demand was being augmented by substantial imports of both concentrates and metal by the Socialist countries.

Lead mine production was forecast by the U. N. to rise by about 200,000 tons worldwide in 1980 for a total of about 2.7 million tons. Refined lead production was expected to total about 3.94 million tons.

FIGURE 6

Lead: Current trends: Metal production and consumption



Source: International Lead and Zinc Study Group

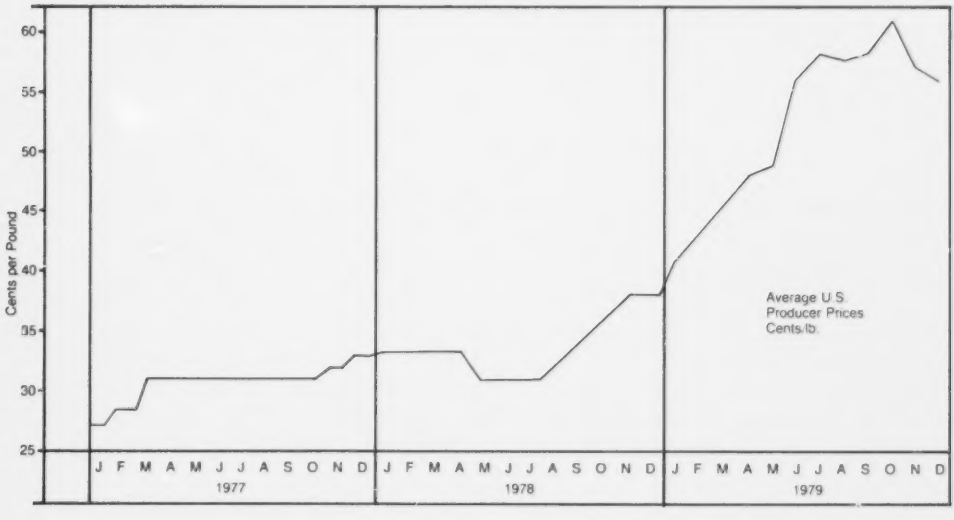
TABLE 11

YEARLY AND MONTHLY AVERAGE LEAD PRICES - U.S.
(Primary Producer - Cents/lb.)

	1977	1978	1979
January	26.87	33.00	40.76
February	28.69	33.00	40.76
March	31.00	33.00	45.75
April	31.00	33.00	48.00
May	31.00	31.00	48.81
June	31.00	31.00	56.51
July	31.00	31.00	58.07
August	31.00	32.17	57.91
September	31.00	34.06	58.00
October	31.02	36.61	61.06
November	32.00	38.00	57.26
December	32.85	38.00	55.95
YEARLY AVERAGE	30.70	33.65	52.64

Source: U.S. Bureau of Mines/from "Metals Week"

FIGURE 7
U.S. PRIMARY PRODUCER MONTHLY AVERAGE LEAD PRICES



ILZRO LEAD RESEARCH 1978-79

Schrade F. Radtke, President
International Lead Zinc Research Organization, Inc.
New York, N.Y.

1978

Preliminary results in the coordinated ILZRO program to synthesize and evaluate new and improved lead oxides for battery paste grids in deep-discharge lead-acid storage batteries were reported in 1978. By year end, 16 new oxides had been developed and evaluated, and an approximately equal number were synthesized but not yet evaluated.

Some of the new oxides excelled in one or the other desired characteristics, but not in all, which was expected at this stage of the effort. The aim is to develop new types of lead oxides which are consistent in quality, high in performance, economical to produce, and superior to battery oxides presently used. If the oxides meet these requirements, they will improve energy density, charge capacity, and cycle life of lead-acid batteries designed for peak-power shaving or load-levelling, as well as for vehicle propulsion applications.

The samples produced in this program were synthesized by a direct current electric arc process or by three chemical and electrochemical methods. They are being tested under a standardized set of procedures developed especially for this program. This test method provides a fast means of identifying battery plates having unusual capacity or charge-discharge cycle life. The synthesized oxides are compared with four commercial oxides which have also been tested by the special method and the results used for comparison purposes.

In lead chemicals, research included a study of lead chemicals as antioxidant additives in asphalt compositions for paving, roofing, and waterproofing. The emphasis, however, was on the paving application where the ILZRO effort was aimed at finding lead chemicals which retard the rate of hardening of asphalt when it is exposed to heat, light, and oxygen.

A major achievement for ILZRO during the year was the drafting of an international standard by the International Standards Organization (ISO) regarding methods of sampling, testing, and permissible limits for lead and cadmium release from ceramic foodware. The draft standard was the outcome of two international conferences on ceramic foodware safety sponsored by ILZRO in previous years. As drafted, the standard will help to protect the ceramic markets for lead, cadmium, and zinc chemicals and facilitate international trade of such dinnerware.

A total of 4,000 wall and floor tiles produced from lead slags were installed in the ILZRO Seneccor House to be evaluated under normal living conditions over the years. A cost study showed that the lead-slag-based tile can be produced at a cost approximately 25% less in fuel and raw material as compared with standard tiles. The experimental work demonstrated that the slag-based tile compositions can be fired to required physical properties as much as 100°C (180°F) below those required for conventional tile. A second project has as its objective the conversion

of lead slags into profitable cementitious building blocks, bricks, and road sub-bases. The work through 1978 demonstrated that such cementitious materials can be produced at relatively low temperatures, such as by steam curing.

The 1978 research in lead environmental and occupational health led to many significant results in areas that have emerged as topics of concern only in the last year or two, including such items as nerve conduction velocity, behavioral effects, and immunology. Other projects attempted to resolve questions posed by governmental regulatory agencies, such as the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA).

On the important issue of carcinogenicity, a previous study and a five-year follow-up, which was completed last year on workers occupationally exposed to lead, has provided sound scientific information that lead is not a human carcinogen. No less than four ILZRO projects were continued in an attempt to identify major sources of lead exposure and another dealt with the amount of lead absorption from airborne lead from automobile exhausts. The data collected in these studies again will provide the industry with the scientific data required when dealing with governmental agencies.

Results of ILZRO's environmental and occupational research on lead were presented at a three-day international symposium held at the University of Cincinnati Dec. 5-7, 1978. Nearly 200 persons from throughout the world were on hand to hear 21 ILZRO researchers speak on their project results.

1979

The lead industry's cooperative research program in 1979 dealt aggressively with such primary markets and concerns as the lead-acid battery, cable sheathing, lead chemicals, ceramics, and environmental health.

In the battery area, ILZRO's projects were directed to development of new battery oxides, battery grids and fundamental research. Three major interrelated projects had a common goal: synthesis of new lead oxides which are consistent in quality (reproducible in manufacture), high in performance, economical to produce and superior to battery oxides now produced. Two of the ongoing projects are concerned with the synthesis of the compounds while the third deals with the evaluation of the more promising experimental oxides produced. By yearend, more than a dozen elements had been tested as dopants in the oxides, with some showing results meriting further investigation.

Good progress is being made on a project to develop antimony-free battery grids that have a good cycle life. Normally, removal of antimony from grid alloys reduces the life of the battery on deep cycling. A successful outcome to this research would improve the competitive position of lead-acid batteries for vehicle propulsion and peak-power shaving by electric utility companies.

Improved splicing and joining of paper-insulated lead-covered (PILC) cables are the objectives of an ILZRO project that moved closer to fruition

by yearend. Interest in PILC cable sheathing is growing because of the increasing failures of cables coated with polymeric materials, particularly for cables in the 5 to 35 kV range. The ILZRO research has identified new joining and splicing techniques which provide modern alternatives to the conventional cast iron box. The new methods do not require the skilled labor previously needed, are more economical to produce, and are applied more simply and quickly. Two of the most promising systems are undergoing further evaluation.

One project that was concluded showed that a family of organic lead chemicals can effectively retard the hardening of asphalt, both in the laboratory and in outdoor weathering conditions. Field testing has shown that these lead compounds increase service life of asphalt roads and that there appears to be no tendency for the lead antioxidants or their degradation products to migrate outside the pavement structure.

In the ceramics area, ILZRO work in 1979 was primarily directed to glazes and glasses used in ceramic foodware. One project, a joint effort with the U.S. Potters' Association, provides for the maintenance of a testing facility to monitor lead and cadmium release from ceramic foodware submitted from a variety of sources. A related effort led to establishment of an international standard for sampling, testing, and permissible limits of lead and cadmium release from ceramic foodware. This was followed late in the year by further efforts to draft another international standard for testing lead and cadmium release from ceramic cookware, infant foodware, and other categories.

A project was completed in which marketable ceramic building tiles were produced from lead and zinc slags. The project included work that extended the use of the tiles by development of an industrially acceptable production process. In another completed project, it was found that ground lead slags are economically viable as a component of blended cements.

In environmental research, ILZRO sponsored work in such areas as pediatric lead absorption, sources of lead exposure, occupational lead exposure, biological interactions of lead, and lead in aquatic environments. One project that was completed in 1979 gave the results of three years study on lead aerosols from automobiles and found that the contribution of lead in air to total lead uptake in humans is about 15% when the person is exposed to 1 ug/m^3. However, for the majority of urban and rural residents, for whom airborne lead averages less than 0.5 ug/m^3 per day, the contribution of air lead to total uptake is less than 10%. In another major study, still continuing, the question of behavioral and neurological effects in children from past lead exposure were evaluated clinically. The study involved 166 children selected from an initial group of 225,000 screened, inner-city children.

LEAD IN CANADA—1978-79

M. J. Gauvin
Energy, Mines and Resources Canada
Ottawa, Ont., Canada

Canadian primary lead is almost entirely coproduced with zinc. Canadian mines supply about 15 percent of all primary lead consumed in the western world, and Canada is the third largest producer and second largest trader of primary lead products. In Canada, refined lead production capacity is about one half the size of primary mine production.

In 1979, there were 29 mine-mill operations in Canada producing lead and zinc concentrates. Foreign and domestic demand for these concentrates during 1979 was exceptionally strong. The utilization of mill capacity at these operations in 1979 is estimated to have been 83 per cent, up two per cent from 1978.

Canada's consumption of primary lead also increased in 1979 to about 73,000 tonnes from 65,000 tonnes in 1978. Consumption of secondary lead is not available, but Statistics Canada's 1978 consumer survey would indicate it to be in order of 40,000 tonnes. In contrast to primary lead, secondary lead consumption may be down from prior years due to reduced quantities of refined lead being used to produce antimonial lead. Coverage of lead consumers in this survey is considered more exhaustive than for zinc and it indicates that the battery industry consumed 79,300 tonnes or 75 per cent of Canada's 105,200 tonnes of lead consumption that year. End-usage for the remaining 25 per cent is obscured

CANADA LEAD PRODUCTION—1978-79

	1978		1979[P]	
	(TONNES)	$	(TONNES)	$
PRODUCTION				
ALL FORMS[1]				
YUKON	80,643	65,466,000	82,232	107,928,000
BRITISH COLUMBIA	71,251	57,842,000	87,653	115,042,000
NEW BRUNSWICK	70,877	57,539,000	75,673	99,319,000
NORTHWEST TERRITORIES	70,071	56,884,000	55,191	72,437,000
NEWFOUNDLAND	8,123	6,595,000	5,860	7,692,000
ONTARIO	6,570	5,333,000	8,619	11,312,000
MANITOBA	565	458,000	307	403,000
QUEBEC	227	184,000	216	283,000
TOTAL	308,327	250,301,000	315,751	414,416,000
MINE OUTPUT[2]	365,782		341,033	
REFINED[3]	194,054		183,769	

[1]Production "In All Forms"–Lead content of base bullion produced from domestic primary materials (concentrates, slags, residues, etc.) plus recoverable lead in domestic ores and concentrates exported.
[2]Lead content of domestic ores and concentrates produced.
[3]Primary refined lead from all sources.
[P]Preliminary

Consumption of Lead in Canada by End-Use Category
1950-1978 (000 tonnes)

	1950[1]		1955[1]		1960		1965		1970		1971		1972		1973		1974		1975		1976		1977		1978	
	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°	1°	2°
Antimonial lead	19.8		29.7		0.2	17.3	1 0	15.4	1.3	.	1.5	17.7	1.9	27.1	1.3	24.6	1.2	13.8	1.1	12.2	1.6	15.7	0.5	13.6	0.5	x
Battery oxides					11.2	0.3	17.2	1.2	18.4	3.4	21.3	2.5	28.5	2.6	28.5	2.7	26.2	4.9	18.9	1.8	25.5	4.8	35.8	5.7	45.7	6.0
Cable covering	11.6		14.0		4.5	1.4	4.1	1.9	2.1	. .	2.1	0.4	3.0	0.4	2.6	x	2.8	0.6	3.5	0.5	2.2	x	2.5	x	x	x
Chemicals	5.6		7.0		10.7	1.6	15.9	1.9	20.0	. .	19.2	3.6	20.3	4.1	24.2	3.5	20.9	x	19.2	x	20.6	x	18.8	x	15.8	5.9
Copper alloys	. .		0.5		0.3	0.1	0.2	0.1	0.3	. .	3.8		0.4		0.4	0.1	0.4	0.1	0.1	0.1	0.3	0.1	0.3	0.1	0.1	0.2
Lead alloys, solders	9.5		2.8		1.4	1.7	2.6	2.4	2.3	2.7	2.1	1.7	2.3	1.7	4.6	1.1	4.3	3.6	2.2	5.1	2.1	5.4	1.2	10.2	1.4	4.4
Other alloys	. .		0.3		0.2	3.6	0.3	1.5	0.3	3.0	0.2	2.1	0.2	4.2	0.5	. .	1.4	5.5	1.1	1.6	0.2	3.2	0.2	3.2	0.5	3.4
Semifinished products	0.6		8.6		7.1	1.6	10.2	3.4	7.8	0.4	5.6	0.5	5.0	0.7	4.1	0.3	4.9	0.3	4.3	0.8	2.7	x	3.3	x	3.8	x
Miscellaneous	2.6		6.5		0.9	1.1	1.0	1.4	2.2	1.5	2.0	1.1	2.2	8.3	2.9	6.5	3.1	5.9	4.2	12.7	6.9	16.4	2.1	9.5[R]	3.8	9.1
Subtotals[2]	49.6		60.1	9.2	36.5	28.9	52.6	29.2	54.7	30.7	54.4	29.6	63.8	49.1	69.0	39.0	65.2	34.7	54.4	34.8	62.2	45.5	64.6	42.3[R]	71.7	29.1
ANNUAL TOTALS[2]	49.6		69.3		65.4		81.8		85.4		84.3		112.9		108.0		99.7		89.2		107.7		107.0[R]		100.8	

Source: Mineral Policy Sector.

[1] Primary and secondary consumption combined.
[2] May not add because of metric conversion and rounding.
. . Not available but included in Miscellaneous.
x Confidential but included in Miscellaneous.
R Revision

LEAD IN FRANCE—1978-79

G. Prevost, Secretary General
Centre d'Information du Plomb
Paris, France

The French lead mine production has been 9% lower than last year but lead production has been higher by 4.2% for total lead production and 5.5% for refined lead production.

TABLE 1—LEAD MINE AND LEAD METAL PRODUCTION
(in 1000 metric tons)

	1978	1979
Lead mine production	32.5	29.5
Total lead production	230.6	240.2
Refined lead production	208.2	219.7

The total consumption of lead was at the same level as in 1978 with very small differences for the different uses, except an increase for chemical compounds.

TABLE 2—CONSUMPTION OF LEAD
(in 1000 metric tons)

	1978	1979
Batteries	108.8	106.0
Cable sheathing	23.0	21.4
Sheet	16.1	16.6
Pipe	4.4	4.1
Other semi-manufacturers (shot, collapsible tubes, fines, etc;)	13.5	12.7
Solders and other alloys	8.9	9.3
Antiknock compounds	14.7	15.1
Chemical compounds	29.0	33.0
Other uses unclassifed	10.0	10.0
Total:	228.4	228.2

Note—The comparison with the years before 1978 has not been given, due to a change in the way used to compile these statistics, both for the refined lead production and for the lead consumption.

LEAD IN INDIA—1978-79

V. K. Sudhakaran
Indian Lead Zinc Information Centre
New Delhi – 110016, India

During 1978, with the commissioning of a new smelter, the primary lead smelting capacity in India increased to 18,000 tonnes.

Primary lead production during the year stood at 10,060 tonnes—a 1/3rd increase over 1977. Production by secondary lead refiners was around 15,000 tonnes. Primary lead production capacity was expanded further to 25,000 tonnes.

Lead imports in 1978 were around 28,000 tonnes, only about half the metal imported during 1977. However, the supply position was not unduly difficult indicating that a good percentage of the metal imported during the previous year was available for use in 1978.

Lead consumption in 1978 was around 65,000 tonnes—a slight fall of about 5000 tonnes from the 1977 peak level.

Automobile production marginally improved during the year and the demand for lead batteries picked up in the original equipment market. Battery exports, too, were good. However, PILC cable market remained stagnant since its production was restricted by governmental fiat.

Primary lead production amounted to 9,728 tonnes in 1979 witnessing a decrease by about 3% compared to the previous year. The production of secondary lead was about 17,000 tonnes from both the organized as well as the small scale sectors.

The national consumption is tentatively placed at 70,000 tonnes approximately showing a growth of 7.5% over 1978.

Lead imports in 1979 would have been around 45,000 to 50,000 tonnes as against 32,000 to 33,000 tonnes in the previous year.

The automobile sector appears to have witnessed an increase in production thus improving the major market for lead. It is understood that batteries performed well in the export market too. With regard to the other application namely PILC cables, there is still a governmental ban on its manufacture.

For 1980-81, Hindustan Zinc Ltd., the primary smelter hopes to produce, providing the power situation improves, 14,000 tonnes of lead. There may be an increase in secondary lead production also in the same period.

LEAD IN JAPAN—1979

Hiroshi Tanaka, Director General
Japan Lead Zinc Development Association
Tokyo, Japan

PRODUCTION OF REFINED LEAD
(in 1,000 metric tons)

1975	1976	1977	1978	1979
194	219	221	228	221

Consumption of refined lead for batteries is gradually increasing due to the expansion of production of automobiles.

The difference between production and consumption has been compensated by the discharge from the stock and the import.

CONSUMPTION OF REFINED LEAD
(in 1,000 metric tons)

Uses	1975	1976	1977	1978	1979
Sheet and pipe	16	23	23	24	21
Storage battery	78	94	104	113	120
Cable sheathing	17	16	23	26	24
Inorganic chemicals	48	62	50	59	62
Others	30	35	46	45	40
Total	189	230	246	267	267

LEAD IN MEXICO—1978-79

A. Guevera
Centro Mexicano de Informacion del Zinc y Plomo, AC
Mexico, D.F.

PRIMARY LEAD REFINING IN MEXICO
(metric tons)

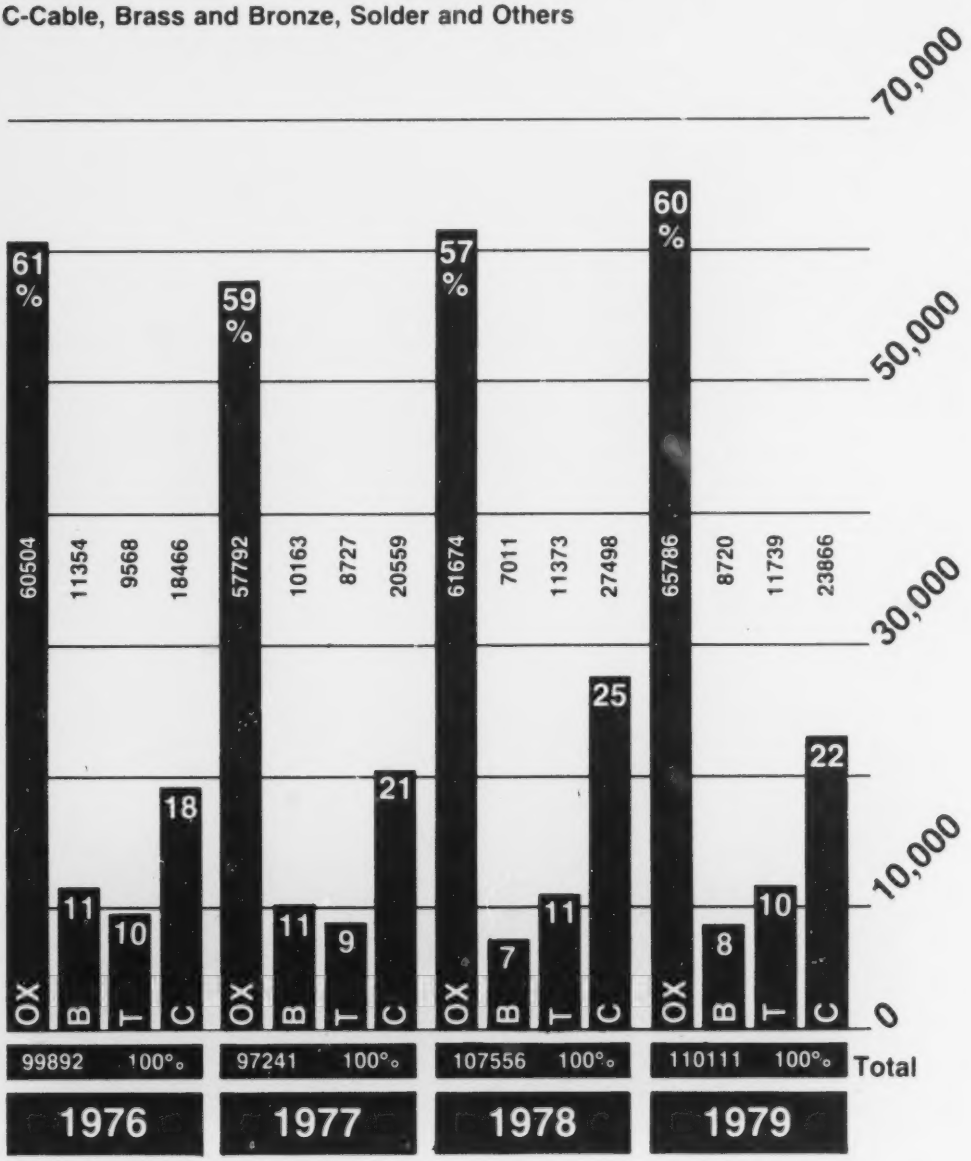
1978	PRODUCTION	NATIONAL CONSUMPTION	EXPORTS	TOTAL SALES
January	19,480	8,639	10,202	18,841
February	18,733	8,265	9,256	17,521
March	21,190	8,356	11,099	19,455
April	17,256	9,083	7,616	16,699
May	17,237	8,803	9,152	17,955
June	17,507	8,482	7,460	15,942
July	19,253	9,230	7,713	16,943
August	18,008	10,126	10,017	20,143
September	18,212	9,574	11,905	21,479
October	19,478	9,748	10,436	20,184
November	19,799	9,466	9,064	18,530
December	19,319	7,784	8,500	16,284
Total	225,472	107,556	112,420	219,976

1979	PRODUCTION	NATIONAL CONSUMPTION	EXPORTS	TOTAL SALES
January	19,889	9,082	9,250	18,332
February	17,400	8,782	10,281	19,063
March	24,733	10,065	12,913	22,978
April	20,134	9,231	9,709	18,940
May	19,806	7,859	9,886	17,745
June	22,127	10,000	10,540	20,540
July	16,184	8,139	9,528	17,667
August	16,804	9,481	8,898	18,379
September	18,339	10,798	8,815	19,613
October	16,018	10,025	6,574	16,599
November	16,286	8,056	7,626	15,682
December	17,036	8,593	5,202	13,795
Total	224,756	110,111	109,222	219,333

Note: Includes lead produced from imported concentrates

CONSUMPTION OF LEAD IN MEXICO BY PRINCIPAL USERS
(METRIC TONS)

OX-Oxides, B-Batteries, T-Tetraethyl lead,
C-Cable, Brass and Bronze, Solder and Others



LEAD IN SCANDINAVIA—1978-79

Magnus Blomkrist
Scandinavian Lead Zinc Development Association
Stockholm, Sweden

SCANDINAVIAN PRODUCTION AND CONSUMPTION OF LEAD
(1,000 metric tons)

	1977	1978	1979 Preliminary
Mine Production	120.1	115.6	114.1
of which:			
Denmark (Greenland)	28.8	30.6	31.9
Norway	3.2	3.1	3.2
Sweden	88.1	81.9	79.0
Smelter Production	95.8	103.2	97.5
of which:			
Denmark	24.2	26.2	30.0
Norway	0.9	0.3	0.3
Sweden	70.7	76.7	67.2
Consumption of refined lead by end uses			
Batteries	35.5	34.9	37.9
Cable Sheathing	15.1	14.0	14.5
Alloys	3.5	3.4	2.9
Others	7.5	8.0	8.0
Total	61.6	60.3	63.3
of which:			
In Denmark	19.2	20.6	22.1
Norway	12.4	12.5	11.5
Sweden	30.0	27.2	29.7

LEAD IN THE UNITED KINGDOM—1979

S.A. Hiscock, Technical Director
Lead Development Association, London, England

The consumption of lead in all forms in the United Kingdom in 1979 amounted to 335,900 tonnes, very slightly less (0.9 percent) than consumption in the previous year. Refined lead from all sources accounted for 333,200 tonnes of the total. Table 1 shows the breakdown of consumption by main uses for the past five years.

TABLE 1. UK CONSUMPTION OF LEAD 1975-1979
(1,000 metric tons)

	1975	1976	1977	1978	1979
Batteries	81.5	89.7	97.2	107.7	113.9
Cable Sheathing	36.5	33.5	31.1	31.0	26.7
Sheet and Pipe	50.3	48.2	47.2	47.9	47.1
Other semi-manufacturers (shot, collapsible tubes, foil, etc.)	10.7	12.9	10.3	10.0	9.7
Antiknock compounds	58.2	56.8	55.4	60.8	58.9
Pigments and other compounds	27.0	32.7	32.3	36.4	34.0
Solder and other alloys	26.2	27.2	27.2	26.0	24.4
Miscellaneous	17.9	19.7	19.3	19.0	21.2
Total consumption	308.4	320.7	320.1	338.9	335.9
(of which refined lead)	306.0	318.3	317.7	336.5	333.2

The pattern of consumption in 1979 was broadly the same as in 1978, the main changes being an increase in battery consumption (up 6,000 tonnes) and a fall for cable sheathing (down 4,000 tonnes). Other uses remained steady and retained their market shares.

Consumption for antiknock compounds was slightly less than in 1978 (but higher than in 1977) but the 2,000 tonne drop is not significant. There were no changes in the permitted lead level in gasoline (0.45 g/l) and export markets, which account for some 85 percent of production, remained strong.

Sheet and pipe maintained the steady course of recent years but while total consumption hardly changed, demand for sheet continued to grow while the use of lead pipe declined further. Other uses—pigments, alloys, shot and collapsible tubes—showed no significant changes in consumption.

TABLE 2. UNITED KINGDOM REFINED LEAD SUPPLIES—1975-79
(1,000 metric tons)

	1975	1976	1977	1978	1979
Production					
from imported bullion	117.9	132.2	139.7	122.8	124.1
from scrap	195.5	209.7	211.4	222.9	244.2
Imports	82.3	68.4	58.3	68.9	47.1
of which from					
Austrlia	36.8	32.5	14.1	22.0	11.5
Canada	41.3	35.8	42.9	38.2	35.5
Other countries	4.2		1.2	7.4	0.1
Exports and re-exports	55.0	60.8	67.5	77.6	92.3

Table 2 shows the make-up of United Kingdom lead supplies over the period 1975-1979.

Refined lead is produced in the United Kingdom from bullion imported from Mount Isa Mines in Australia and from scrap lead. Production from imported bullion was practically the same as in 1978 but the contribution from scrap rose by some 21,000 tonnes (9.6 percent). This followed an 11,500 tonne increase (5.5 percent) in 1978. These increases in recovery from scrap arise mainly from a new 30,000 tonne capacity secondary refinery opened by Britannia Lead (Mount Isa's UK subsidiary) in late 1977, but also reflect the growing contribution that scrap lead is making to supplies in general.

The production of bullion at the ISF zinc plant at Avonmouth, which is exported to Germany FR for refining, increased by 2,000 tonnes in 1979 to reach 32,300 tonnes.

Total imports of refined lead declined (after rising in 1978) falling by 21,800 tonnes (32 percent) to 47,100 tonnes. Supplies from Australia, at 11,500 tonnes, were about half the 1978 tonnage but imports from Canada fell by only 2,700 tonnes (7 percent). Exports of refined lead rose by 19 percent to 92,300 tonnes.

LEAD INDUSTRIES ASSOCIATION, INC.

The Lead Industries Association, Inc. was organized in 1928 and now includes 80 corporate members and six associate members representing all segments of the lead industry.

LIA is a non-profit trade association for the lead industry of the United States with sister associations in major countries throughout the world. The association neither produces nor sells lead, but collects and distributes information relative to the uses of this metal.

An extensive library of lead information is housed at the Association's New York headquarters and data pertaining to lead and lead products is available through letter or telephone inquiry to the technical service department. The staff of the Lead Association will cooperate without obligation in the solution of your lead problems.

MEMBERSHIP

Any individual corporation, association, partnership or other organization within the U.S. engaged in lead mining, primary or secondary smelting and refining, or manufacture of products which consume lead, or which is engaged in one or more such activities outside the U.S. and markets lead or lead products within the U.S. is eligible for membership in the Association. Associate memberships are available to those engaged in lead mining, smelting and refining, manufacturing or consumption outside the United States.

LEAD INDUSTRIES ASSOCIATION MEMBER COMPANIES

Allied Lead, Inc.
Alpha Metals, Inc.
Amax Lead & Zinc, Inc.
Ames Metal Products Co.
ASARCO Incorporated
Associated Lead, Inc.
*Associated Metals and
Minerals Corporation
*Australian Min. & Smelt. Ltd.
The G.A. Avril Company
Lead Products Division

Baltimore Lead Burning Corp.
Bergsoe-Boliden, Inc.
The Broken Hill Associated
Smelters Pty, Ltd.
The Bunker Hill Company

C & D Batteries Division
Eltra Corporation
Canada Metal Co. Ltd.
M.C. Canfield Sons
Chloride Inc.
Cominco American Inc.

Daelco Inc.
Day Mines, Inc.
Delco-Remy Division
General Motors Corp.
Division Lead Company
Dixie Metals Company
Dresser Industries, Inc.
M. W. Dunton Company
E. I. duPont de Nemours & Co.
Petroleum Chemicals Division

Eagle-Picher Industries, Inc.
Chemicals & Fibers Division
East Penn Manufacturing Co., Inc.
Ethyl Corporation
Exide Corporation

Federal Alloys Corporation
Federated Metals Corporation
Aaron Ferer & Sons Company
Fry's Metals Inc.

Gardiner Metal Company
General Battery Corporation
*Gerald Metals, Ltd.
Globe Battery Division
Johnson Controls, Inc.
Gould Inc.
Metals Division

Hammond Lead Products, Inc.
Hercules Chemical Co., Inc.
Homestake Mining Co.
The O. Hommel Company
Houston Lead Company

Indium Corporation of America
Industrial Minera Mexico, S.A.
Industrial Smelting Company
*Industries Arpron, S.A.I.C.
Inland Metals Refining Co.
Interstate Lead Co.

Johnson Manufacturing Company

O. G. Kelley & Company, Inc.
Kester Solder Company
Keystone Resources
KW Battery Company

Lake Chemical Co.
Lukens Metal Company

Metallurgical Resources, Inc.

Nalco Chemical Company
National Smelting & Refining Co.
New England Lead Burning Co., Inc.
Noranda Sales Corporation Ltd.

Oatey Co.
Oxide & Chemical Corporation
Ozark Lead Company

*Penarroya
Phelps Dodge Corporation
Pittsburgh Metal and
Equipment Co., Inc.
Powerlab Inc.
PPG Industries, Inc., Chemicals-U.S.
Price Metals, Inc.

Quenell Enterprises, Inc.

Refined Metals Corporation
Republic Metals Co., Inc.
Roth Brothers Smelting Corp.
RSR Corporation

St. Joe Minerals Corp.
Schuylkill Metals Corp.
Sub: Arrow Electronics, Inc.

Taracorp Inc.
*Tonolli North America

U.S.S. Lead Refinery , Inc.

Vernitron Piezoelectric Division
The Victory White Metal Company
Hyman Viener & Sons
Vulcan Lead Products Company

Willard Lead Products Company

**Associate Member*